REMARKS

Rejection of Claims on Reference Grounds, and Traversal Thereof

In the July 30, 2003 Office Action, the Examiner finalized the previous rejections of claims 1-9 and 35-42 on reference grounds, despite the patentable distinctions of the claimed invention over the Hiroharu, Streit, Schetzina, and Pao references, as pointed out in Applicants' May 20, 2003 Response.

Specifically, in response to the fact that **the primary reference Hiroharu does not provide any derivative basis for forming a high quality HEMT structure having an AlGaN layer of low Al content (i.e., Al content x<0.20) on an InGaN channel layer**, as expressly required by all pending claims of the present application, the Examiner asserted that "the mole fraction of aluminum in the AlGaN layer is merely a process optimization," that "the applicant has not established the criticality of the mole fraction stated," and that "these mole fractions are in common use in similar device in the art" (see the July 30, 2003 Final Office Action, page 6, Response to Arguments, second paragraph).

Such assertions by the Examiner are incorrect.

First, as previously explained in great details in the May 20, 2003 Response, the device performance of conventional AlGaN/GaN HEMT structures is significantly limited by persistent photoconductivity (PPC) and drain I-V collapse caused by the defect-donor complexes (DX centers) formed in **high Al content AlGaN layers**, which are defined compositionally as **$Al_xGa_{1-x}N$, where x>0.20**.

Such high Al content AlGaN layers were considered by the conventional wisdom in the art as being necessary for achieving piezoelectric-induced doping and critical for avoiding degradation of the structural or electrical properties of the channel layer thereunder. Mere reduction of the mole fraction of aluminum in such AlGaN layer of the conventional AlGaN/GaN HEMT structures to below 0.20 would result in less piezoelectric-induced doping and degradation of the structure or electrical properties of the channel layer thereunder, and would further reduce the device performance of the conventional AlGaN/GaN HEMT structures. A person ordinarily skilled in the art would not choose to reduce the mole fraction of aluminum in the AlGaN layer, knowing the deleterious impact such reduction would bring on the device performance.

Therefore, **reduction of the mole fraction of aluminum in the AlGaN layer is not "merely a process optimization"** that a person ordinarily skilled in the art would have chosen to adopt, despite the Examiner's unsupported assertion that "the mole fraction of aluminum in the AlGaN layer is merely a process optimization" in the July 30, 2003 Final Office Action.

Second, the criticality and advantages of having an AlGaN layer of reduced Al content have already been explained clearly in Applicants' May 20, 2003 Response, despite the Examiner's assertion that "the applicant has not established the criticality of the mole fraction stated." Specifically, **use of such AlGaN layer of reduced Al content avoids formation of the defect-donor complexes (DX centers) that are generally associated with high Al content AlGaN layers, which in turn reduces the persistent photoconductivity (PPC) and drain I-V collapse and significantly improves the device performance**. The present invention, by providing an InGaN channel layer on the GaN buffer layer, successfully employs "reduced Al content AlGaN layers without significant reductions in piezoelectric-induced doping or degradation of the structural or electrical properties of the channel layer" (see the instant specification, page 6, lines 3-5). Therefore, the present invention achieves better device performance by using the reduced Al content AlGaN layers, while avoiding the deleterious impact such usage may bring by concurrently providing an InGaN channel layer thereunder.

Third, reduced Al content AlGaN layers are not in common use above a channel layer, despite the Examiner's assertion that "these mole fractions are in common use in similar devices in the art" in page 6 of the July 30, 2003 Final Office Action.

The Examiner has not provided one single reference that discloses a HEMT device containing reduced Al content AlGaN layers above a channel layer. In respect of the Examiner's unsupported assertion, applicants hereby require the affidavit of the Examiner under the provisions of 37 CFR §1.104 ("Nature of examination"), which states in paragraph (c)(2) that

> **"[i]n rejecting claims for want of novelty or for obviousness, the examiner must cite the best references at his or her command"**

and in paragraph (d)(2) requires that

> **"[w]hen a rejection in an application is based on facts within the personal knowledge of an employee of the Office, the data shall be as specific as possible, and the reference must be supported, when called for by the applicant, by the affidavit of the employee, and such**

affidavit shall be subject to contradiction or explanation by the affidavits of the applicant and other persons."
(emphasis added)

Applicants therefore call for the Examiner's affidavit specifically supporting the Examiner's statement that the Al mole fractions of less than 0.20 are "in common use" in a AlGaN layer formed above a channel layer.

This call for the Examiner's affidavit is based on the fact that **Applicants are unaware of any references or knowledge in the field of semiconductor devices that support the Examiner's contention of "common use" character of the features that in fact patentably distinguish the Applicants' claimed invention over the art**.

The Applicants therefore assert that there is in fact no *prima facie* case of obviousness, since the primary reference Hiroharu is fundamentally deficient in teaching or suggestion of Applicants' recited HEMT device having an InGaN channel layer and an AlGaN layer of reduced aluminum content of less than 0.20 thereon, and none of the secondary references remedies such deficiency of the primary reference Hiroharu.

Further, in the February 12, 2003 Office Action, the Examiner conceded that the primary reference Hiroharu does not disclose any GaN/InGaN or InGaN/InGaN HEMT structure (see page 4, second paragraph of the February 12, 2003 Office Action), but attempted to remedy such deficiency of Hiroharu by citing the Schetzina reference. In the May 20, 2003 Response, the Applicants explained the incombinability of the Hiroharu reference and the Schetzina reference, based on the fundamental structural differences between the HEMT structure disclosed by Hiroharu and the MQW structure disclosed by Schetzina. In response to the Applicants' explanation of incombinability of the Hiroharu and the Schetzina references, the Examiner shifted his position regarding disclosure by the Hiroharu reference and asserted that "Hiroharu discloses an InGaN/GaN HEMT and Hiroharu also discloses, generally, the GaN layer could be represented by an AlGaN, an InGaN, an AlGaInN, a BGaInN, etc. ([0011])" and therefore "it would have been obvious the channel Hiroharu's device could be InGaN/InGaN HEMT" (see the July 30, 2003 Final Office Action, page 7, first paragraph."

Applicants hereby disagree, on the basis that the Examiner improperly mischaracterized the disclosure of the Hiroharu reference. **The Hiroharu reference does not suggest or teach in any**

manner that the GaN layer in an InGaN/GaN HEMT device can be represented by AlGaN, InGaN, AlGaInN, or BGaInN, despite the incorrect assertion made by the Examiner.

Paragraph [0011] of Hiroharu only discloses **a GaN layer and a semiconductor layer** that are both n-type, wherein **the semiconductor layer (not the GaN layer, emphasis added) can be, for example, a GaInN layer, an AlGaInN layer, a BGaInN layer**, and **wherein such semiconductor layer typically grows on the GaN layer**, according to the English translation of the Hiroharu reference provided by the Examiner with the February 12, 2003 Office Action. For ease of reference, the exact English translation of the paragraph [0011] of the Hiroharu reference as provided by the Examiner is reproduced at below:

> **"[0011] In this invention, a GaN layer and a semiconductor layer are n types each typically. Here, the carrier concentration of an n type GaN layer is x(1-5)1017cm-3. Moreover, when some examples of a semiconductor layer are given, they are a GaInN layer, an AlGaInN layer, a BGaInN layer, etc. This semiconductor layer grows alternatively on a GaN layer typically."**

It is clear therefrom that the examples provided by Hiroharu in paragraph [0011], i.e., the GaInN, AlGaInN, and BGaInN layers, are directed to the semiconductor layer grown on the GaN channel layer, but not to the GaN channel layer itself.

Therefore, **Hiroharu only discloses in paragraph [0011] HEMT devices having a GaN channel layer and an additional semiconductor layer of GaInN, AlGaInN, or BGaInN grown thereon, but it does not provide any derivative basis for a HEMT device having an InGaN channel layer and an additional layer comprising GaN or InGaN thereover, as required by all the pending claims 1-9 and 35-42**.

Therefore, claims 1-9 and 35-42 of the present application patentably distinguish over all the cited references, by requiring **a gallium nitride-based HEMT device** that has **a channel layer comprising an InGaN alloy and at least one additional layer thereover**, wherein the at least one additional layer **comprises material selected from the group consisting of AlGaN, GaN, and InGaN**, with **the proviso that when said at least one additional layer comprises AlGaN material, said AlGaN material is $Al_xGa_{1-x}N$, wherein x is less than 0.2**.

Applicants hereby respectfully request the Examiner to reconsider, and upon reconsideration to withdraw, the rejections of claims 1-9 and 35-42 as amended herein.

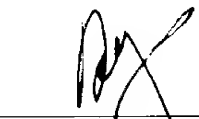
CONCLUSION

Claims 1-9 and 35-42 as amended herein are now in form and condition for allowance. Issue of a Notice of Allowance for the application is therefore requested.

No fee is rendered payable herein. Nevertheless, the Office is authorized charge any fee that is deemed necessary for entry of this Amendment to Deposit Account No. 08-3284 of Intellectual Property/Technology Law.

If any issues remain outstanding, incident to the formal allowance of the application, the Examiner is requested to contact the undersigned attorney at (919) 419-9350 to discuss same, in order that this application may be allowed and passed to issue at an early date.

Respectfully submitted,



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